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An Over-Optimistic Pioneer Fringe? Environmental Perspectives on Medieval Settlement Abandonment in Þórsmörk, South Iceland

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INTRODUCTION

In this paper we assess environmental factors that may have contributed to the medieval abandonment of a group of five farms in Þórsmörk south Iceland (Figs. 1 and 2). The upland margins of the settled areas of Iceland are characterised by abandoned farms, evidence of a contraction in the occupied zone. We need to understand possible cultural and environmental reasons for this in order to determine its significance.

SETTLEMENT CHANGE

When considering recent changes to the upland margin of settlement in northern, sub-polar latitudes, one issue is the role of climate change in general and the extreme decades of the post 14th century 'Little Ice Age' (LIA) in particular. As the LIA included some of the most unfavourable decades of climate during the last 1400 years (Meeker and Mayewski 2002), were farms sited at the upland frontiers of settlement in Iceland abandoned as a result of these or other similar but less pronounced spells of colder, wetter and/or stormier conditions? In which case, are these episodes present in proxy records of climate change, and are they apparent in local records of environmental change? It is possible that a series of disastrous years could have forced people to abandon farms in areas where the snow lay longer, livestock died more frequently, the

growing season started later and the winters set in earlier. But for any comparatively short-lived episode of change to have become an enduring change, something must have acted to inhibit re-occupation. A declining population is one possibility (that may be apparent in other records), environmental degradation is another (that should leave physical evidence visible today) and cultural change is another (but that may leave no physical trace at all).

So key questions are whether there is any evidence of environmental degradation, or not; and if there is, when did it begin (and end) and where did it occur? As a further twist for arguments blending cultural and environmental factors, environmental degradation may have affected the upland margins even in the absence of changing climate. Once subjected to the unprecedented introduction of grazing mammals, combined with woodland and scrub clearance, perhaps landscape degradation was inevitable and progressed to the point where settlement viability was affected. In addition, other decisive, landscape changing environmental pressures may have arisen abruptly. Rather than a gradual reduction of vegetation, decline of livestock, or erosion of soil that builds to reach a threshold, the crisis may arise suddenly as a result of catastrophes such as volcanic eruptions. Ash falls, and their aftermath in terms of livestock mortality, buried hayfields, clogged streams, enhanced erosion and unstable surfaces may have brought settlements at the upland frontier to a time of crises.

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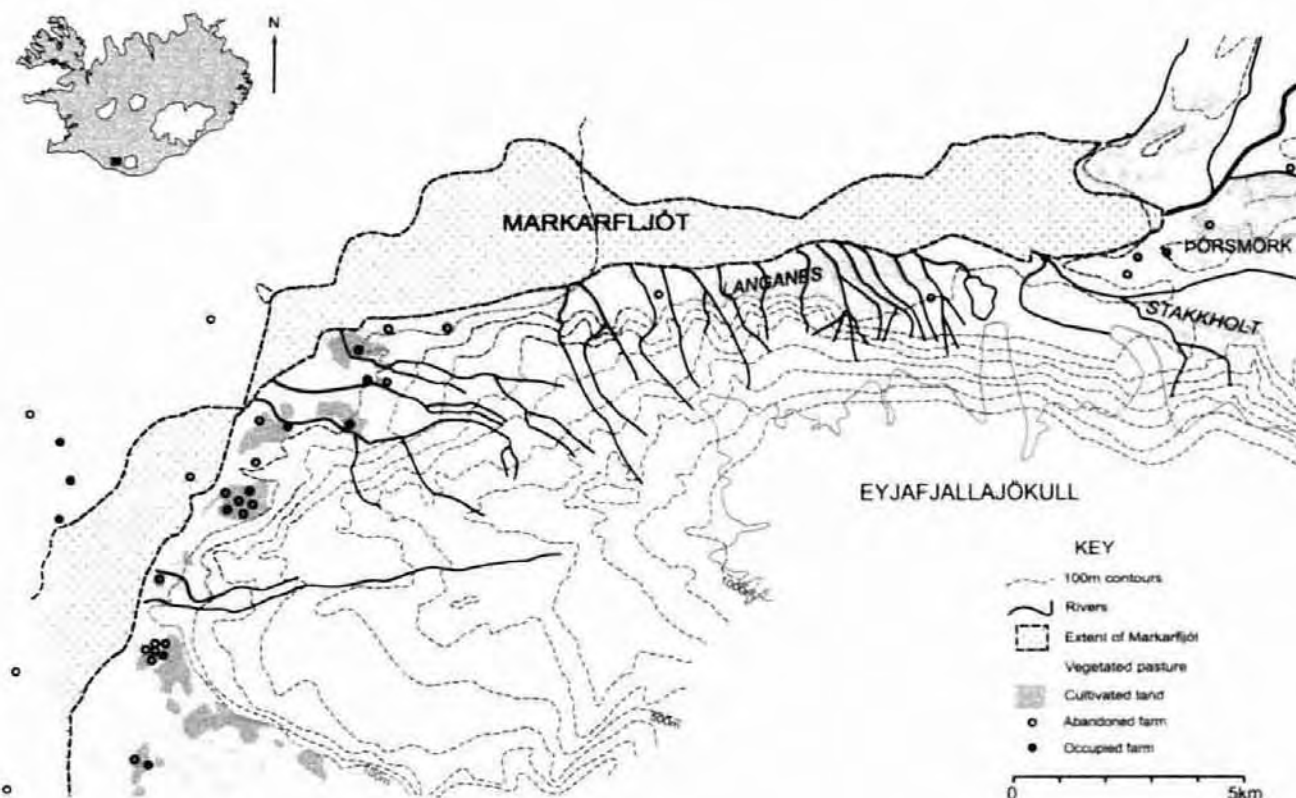


Fig. 1. Þórsmörk in south Iceland.

Alternatively, fundamentally different explanations may actually be more appropriate. Environmental change may be irrelevant. For example, an 'abandoned frontier' may be created by the simple changes in the overall pattern of settlement distribution (cf. Vésteinsson 1998; Vésteinsson *et al.* 2002). The upland margin (as opposed to the coast) is special because of the spatial asymmetry created by land use that extends beyond the places people could choose to live. A variety of changes in farm site location in relation to the lands used by the farm could produce the observed pattern. These could include a simple reduction in the overall number of occupied sites. Alternatively, the development of a hierarchy of many smaller and a few much larger farms from an initial pattern of more equally-sized land holdings could create the same overall effect. More subtle changes could also be crucial, given a potentially asymmetric 'pull' towards the lowlands: within any pattern of differently sized landholdings a marginal zone of abandoned sites could be created if farm buildings were moved to optimise their location in terms of resource use within the holding (for example, from the geographic centre towards the more productive, lower land). Alternatively, within unchanging

landholdings, settlements could be shifted to minimise journey times between farms, and the occupied zone 'pulled' downhill.

In order to evaluate these various explanations, some fundamental field data is required. In our case studies, do environmental changes occur in the times leading up to settlement abandonment? If they do not, then their role in the debate has to be considered minimal. If degradation does occur, so raising the possibility that it could contribute, then questions of timing become vital. Do landscape changes occur in the absence of climate change, or is there evidence of one reinforcing the other?

The occurrence of suitably timed climatic and/or environmental changes does not necessarily mean that they contributed to the creation of an abandoned frontier, but crucially their absence would substantially strengthen the view that they were irrelevant.

APPROACH AND METHODS

During the late 9th-early 10th century *landnám* farms were established in the inland valleys of Þórsmörk, above the confluence of Markarfljót and Krossá, on

the edge of the southern highlands. *Landnámabók* mentions two settlers in Þórsmörk (named Steinfinnr and Ásbjörn) (ÍF 1: 344, 346). Five sites have been discovered in the area, now called Steinfinnsstaðir, Húsadalur, Þuríðarstaðir, Þuríðarstaðir efri and Bæjaralda (Sveinbjarnardóttir 1983; Tómasson 1996, 124-134). Only the Húsadalur site has escaped erosion. At the other four, frost action, deflation and water erosion have exposed artefacts ranging in ages from the 9th to 12th centuries. The dates of these artefacts and accounts in the 13th century sources *Sturlunga saga* (SS I: 532) and the *Bishop's sagas* (BS I: 291), suggest that the area was uninhabited at the time they were written, implying that these settlements were abandoned by the 13th century. From that time onwards, permanent settlement effectively ended in the area, as only the site in Húsadalur was ever re-occupied, and that was for one year only in the early 19th century as a result of 18th century legislation aimed at strengthening settlement in the country (Sveinbjarnardóttir 1983). In this respect, Þórsmörk is distinctive, as although farm abandonment also occurred in lowland areas, in those parts other settlement did continue.

Today, to the south/east of the Markarfljót river, the uppermost farm site lies about 20 km down stream from Þórsmörk at Stóramörk, and on the northern/western side, the highest settlement is now c. 15 km downstream at Fljótsdalur. As a result the Þórsmörk sites represent an 'abandoned frontier', although, as with many similar areas of Iceland, site abandonment did not mean that exploitation of the landscape came to an end. The Þórsmörk woodland was conserved and utilised as a valuable source of wood and charcoal into the early modern period (Tómasson 1996, 161-181). Despite woodland survival in sheltered valleys, the hilltops have lost much of their soil cover and erosion in the form of gullying and the eroding faces cutting horizontally into the surviving soils ('rofabards' cf. Arnalds 1999) have encroached into the lowest valleys. In addition, most of the actual farm sites have also been stripped of soil cover. If this process began before the sites were abandoned, soil erosion is a possible factor in the desertion of these Commonwealth period sites (Sveinbjarnardóttir 1982).

We assess environmental history using sediment profiles and tephrochronology (e.g. Thorarinnsson

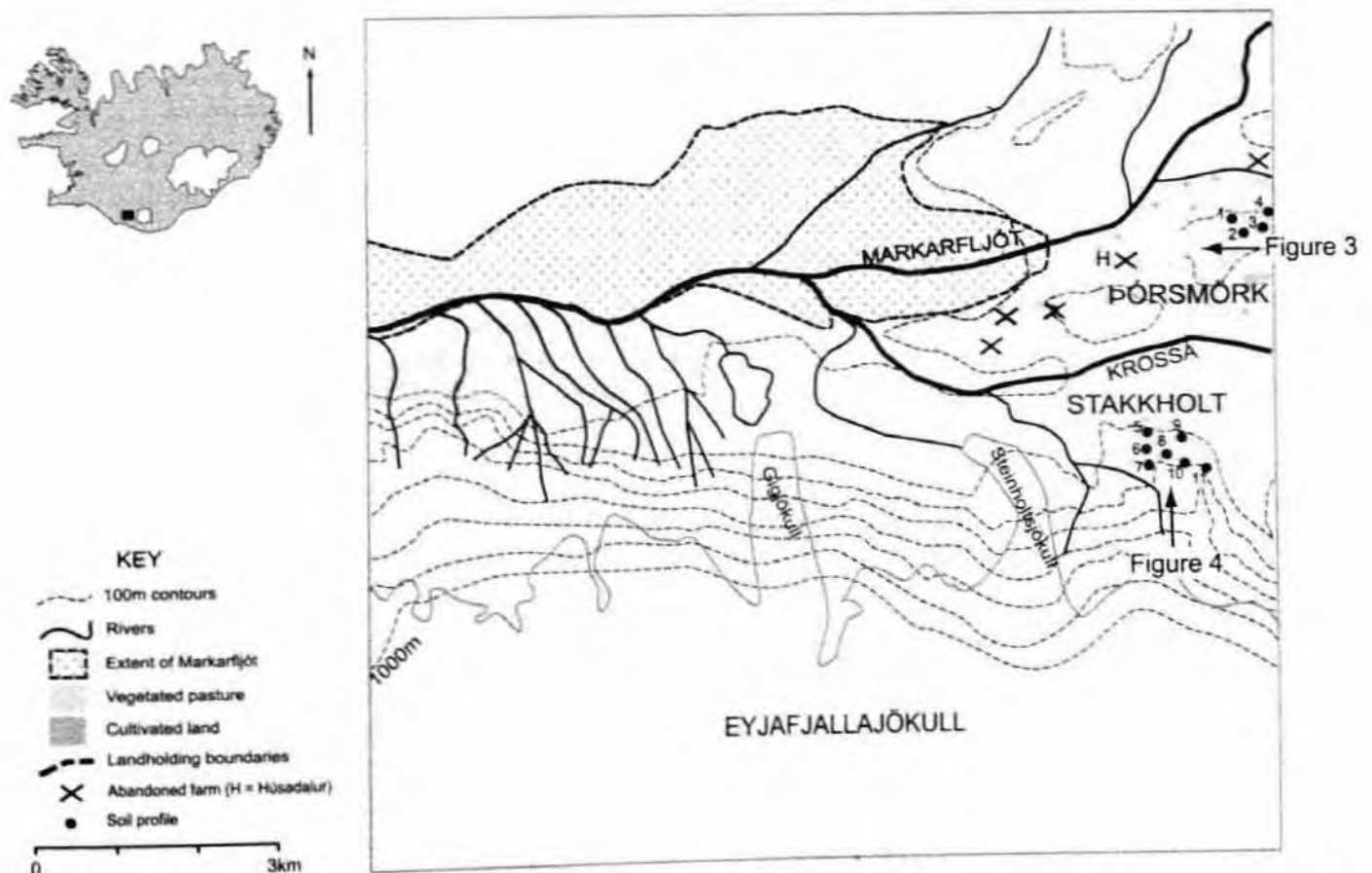


Fig. 2. The location of soil profiles within the landholdings of the Þórsmörk area. Arrows indicate the location and orientation of the photographs shown in Figures 3 and 4.



Fig. 3. The Þórsmörk study area looking west. Húsadalur lies in the valley at the centre of the picture; within the valleys of Þórsmörk woodland survives, on the upland slopes soils are patchy and generally shallow.

1944, 1961, 1981; Dugmore and Buckland 1991). Tephrae are identified using a suite of macroscopic characteristics (e.g. Fig. 5) supported by geochemical analysis (e.g. Fig. 6). The soils considered are andisols formed by the accumulation of fine-grained aeolian sediments intercalated with horizons of volcanic ash, or tephra laid down by the eruption of volcanoes generally within 50 km of the study area (Thorarinsson 1967, 1975; Larsen 1984; Larsen *et al.* 1999; Dugmore *et al.* 2000). In the time since the settlement of Iceland the rate of aeolian sediment accumulation can be assumed to reflect the rate of soil erosion in the immediate surroundings (< 1 km) (Dugmore and Erskine 1994; Dugmore *et al.* 2000). Increases in aeolian sediment accumulation can be related to increases in soil erosion, so profiles have been measured to determine the nature and thickness of sediment horizons between tephra layers of known ages. In addition, profiles were examined for erosional unconformities, which are direct evidence of phases of erosion, and for different types of sediments, such as sands and gravels, evidence of non-aeolian processes. To ensure accuracy, excavations were created with a minimum horizontal exposure of 50 cm.

Two areas were investigated (Fig. 2); the first within the landholdings of the Þórsmörk farms, c. 1.5 km east of the site of Húsadalur. We considered an area of a higher plateau fragment (c. 400 m above sea level) 100–150 m above small sheltered

valleys where woodland survives today (Fig. 3). This area is more typical of the wider landscapes of the district and is potentially sensitive to key landscape changes that might have affected the viability of the farms. A second topographically and geomorphologically similar area called Stakkholt was selected that lies 2 km to the south on the opposite side of the major glacial river Krossá (Fig. 4). Though the precise use of Stakkholt in the centuries immediately after landnám and during the occupation of Þórsmörk cannot be known with certainty from the written sources, key points are that firstly, the deep, wide and fast-flowing waters of the Krossá prevents easy access from the farms in Þórsmörk (access is actually easier from the Mörk and Dalur farms down valley), and secondly, in later centuries the rights of use were different for Stakkholt and Þórsmörk. If we find environmental changes restricted to Þórsmörk in the period before abandonment it strengthens the argument that specific human actions were responsible rather than some regionally applicable factor such as climate change. Our approach to the environmental data is therefore centred on the evaluation, comparison and contrasts of evidence for landscape change in the two study areas.

EVIDENCE OF ENVIRONMENTAL CHANGE

Evidence of environmental change has been successfully dated using tephrochronology, which is based on a combination of field stratigraphy (Fig. 5)

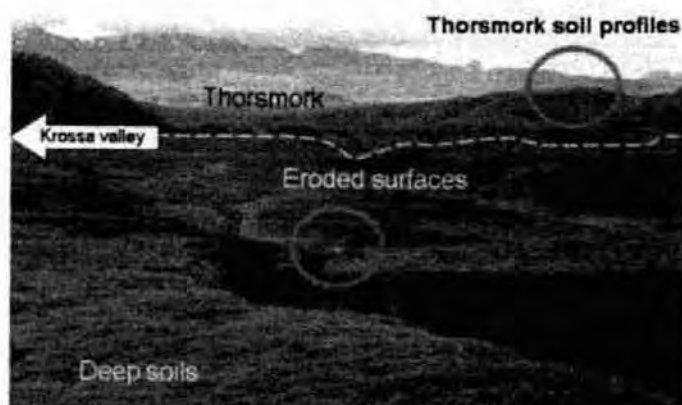


Fig. 4. The Stakkholt study area looking north towards the Þórsmörk study area. No woodland survives here, but there is a discontinuous cover of deep soils.

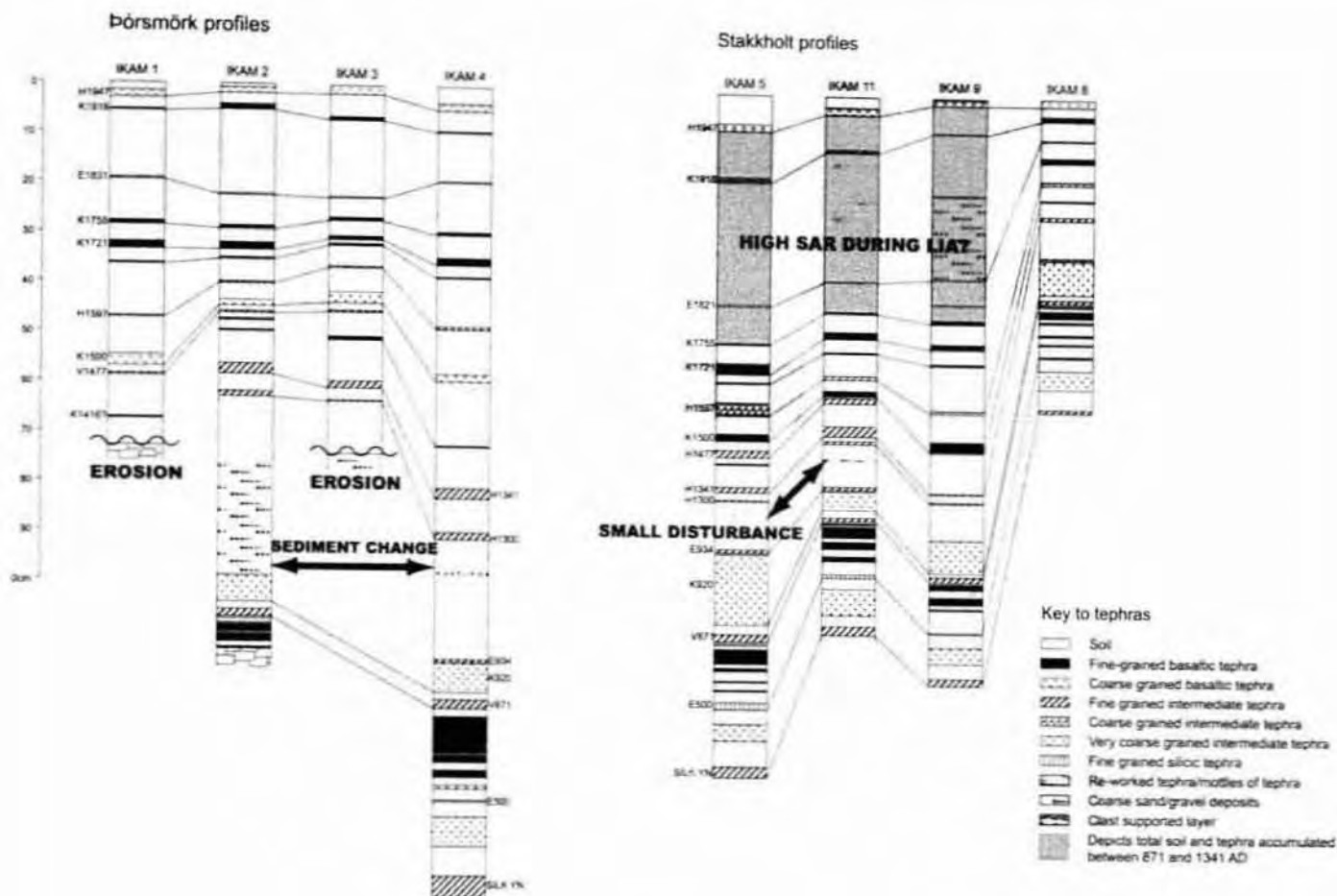


Fig. 5. Soil sections from Þórsmörk and Stakkholt.

and geochemical analyses of key layers (Fig. 8). In Þórsmörk, there is evidence for discrete episodes of landscape instability that can be constrained to between the 10th and 13th centuries, and localised episodes of soil erosion to bedrock that ended before 1300 AD (Fig. 5). The low-angled, upland slopes we considered are characterised by patches of comparatively shallow soils, generally less than 1 m deep. A series of profiles excavated through the full depth of these shallow soils shows that they do not contain any tephra older than that produced by Hekla in 1300 AD (H1300: Thorarinsson 1967), for example the profiles IKAM1 and IKAM3 in Figure 5. Notably absent are the tephra produced around the settlement period (Larsen 1996) including the Landnám tephra of 871±2 (Larsen 1984; Grönvold *et al.* 1995), Katla c. 920 (Halflidason *et al.* 1992) and Eldgjá c. 935 (Zielinski *et al.* 1995).

In this area, we could expect soils and tephra layers to have been accumulating since the early to mid Holocene. It is a place where birch (*Betula* sp.) and willow (*Salix* sp.) scrub with a dense understorey can thrive, slopes are relatively gentle and is

close to a network of interfluvies. The substrate of diamicton over bedrock is stable. The lack of soils older than 10th century indicates that this area was stripped to the basal diamicton/bedrock at that time. On lower slopes in depressions created by shallow bedrock channels some deeper, older soils do survive. Here, the last 1600 years (after the deposition of Katla silicic tephra SILK YN ca. 410 AD) are characterised by the accumulation of aeolian silts and tephra layers, except for the period between E935 and H1300, when coarse sand and gravel beds were formed within the silt (e.g. Fig. 5; IKAM4). Tracing these coarse water-lain sediments uphill, they thicken towards areas where soils had been eroded to the underlying diamicton before 1300 AD (Fig. 5; IKAM2).

The profiles in the Stakkholt study area present a different record (e.g. Fig. 5; IKAM5, 9, 8 and 11). The present landscape is similar to that of the study area in Þórsmörk; patches of soil separated by areas eroded to the underlying diamicton and/or bedrock (Fig. 4). The soils are generally much deeper (>3 m) with a very long record of intercalated soils and tephra layers. The upper parts show

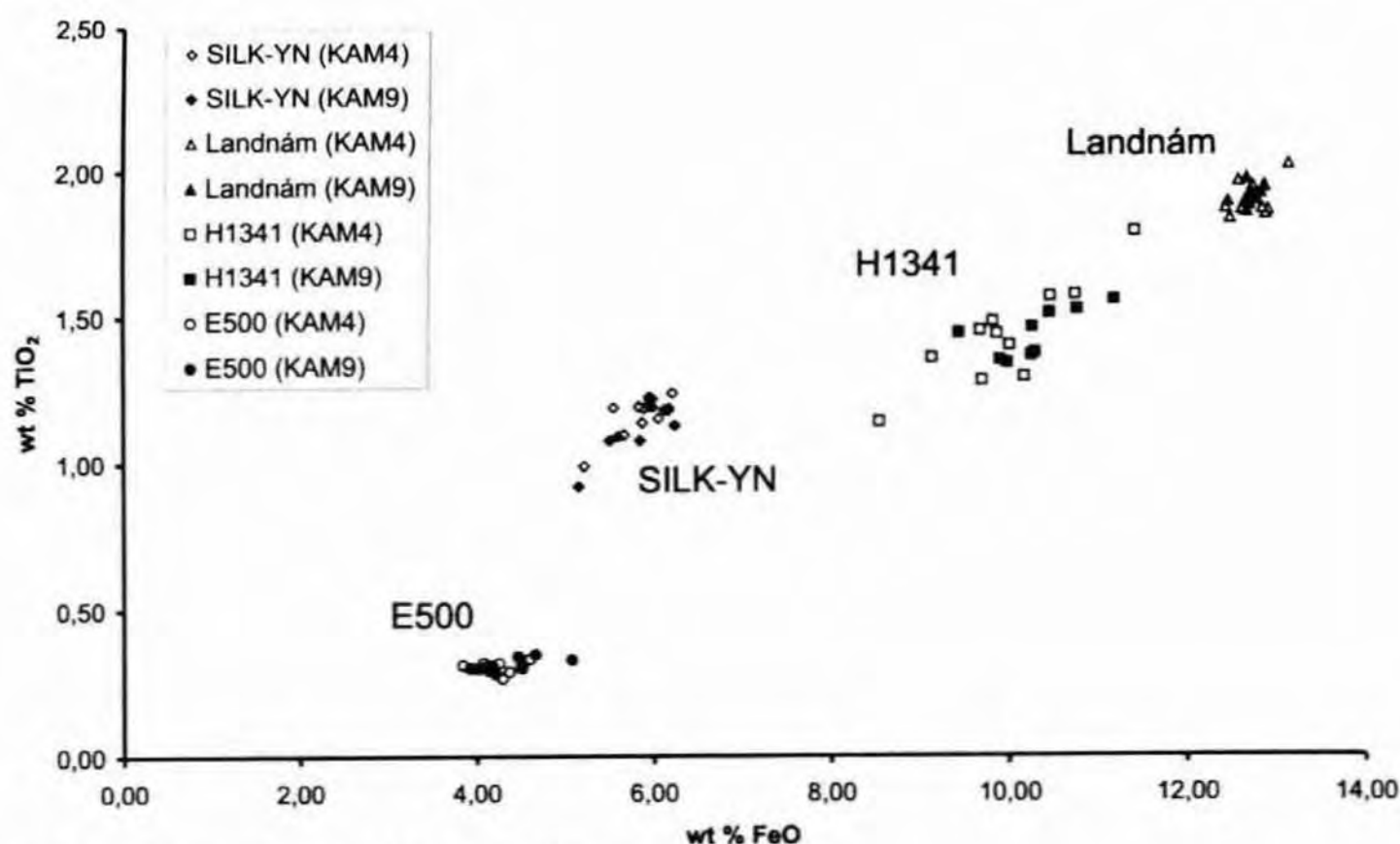


Fig. 6. Geochemical analysis of key tephra layers.

that there is no evidence of an erosion phase before 1300 AD, because the record is complete long into prehistory. Evidence is, of course, missing from the areas currently lacking soils, but the lack of substantial local erosion in the 10th-13th centuries can be inferred from the generally slow rates of aeolian sediment accumulation throughout this period. If significant erosion had taken place locally, the surviving profiles would record this episode as a phase of increased accumulation, but this is not the case (Fig. 5; IKAM8 and IKAM9). Profiles were sited at the foot of slopes rising to the south above the investigated terrace to assess sensitive records of slope stability. These profiles indicate some limited disturbance in the 10th-13th centuries (e.g. Fig. 5; IKAM5 and IKAM11). More significant increases in sediment accumulation and changes in the nature of sedimentation occur in the 19th century, a pattern that extends onto the terrace at Stakkholt (e.g. Fig. 5; IKAM 9), but not into Þórsmörk (e.g. Fig. 5; IKAM 1-4).

In summary therefore, local erosion in the 10th-13th centuries in the Þórsmörk area contrasts with stability in Stakkholt; later, 19th century 'Little Ice Age' stability in the Þórsmörk area contrasts with episodes of instability in Stakkholt.

DISCUSSION

The soil profiles contain convincing evidence that environmental impact did occur in the landholdings belonging to the Þórsmörk farms in the period leading up to their abandonment. This degradation could have spread across much of the land above 350 m, and so affected a large proportion of the land utilised by the farms. At the time of the initial settlement the areas that were to degrade soon afterwards probably formed an open landscape above the limit of continuous woodland. Low scrub, heath and grasslands could have presented an inviting prospect to Norse pastoralists seeking land to support livestock. Here was the potential for 'false analogy', because these areas of late 9th century Iceland looked very similar to contemporaneous landscapes in Scandinavia and the northern British Isles. Similarities of overall landscape appearance would have extended to similarities of individual species of plants, all of which could have been recognised by somebody familiar to the plants of the uplands of northwest Europe. The problem was that parts of the Icelandic, Scandinavian and British landscapes were similar in appearance for very different reasons. Many 9th century grasslands in NW

Fig. 7a. A proxy record for North Atlantic storminess change (GISP2 Na* [sea salt])

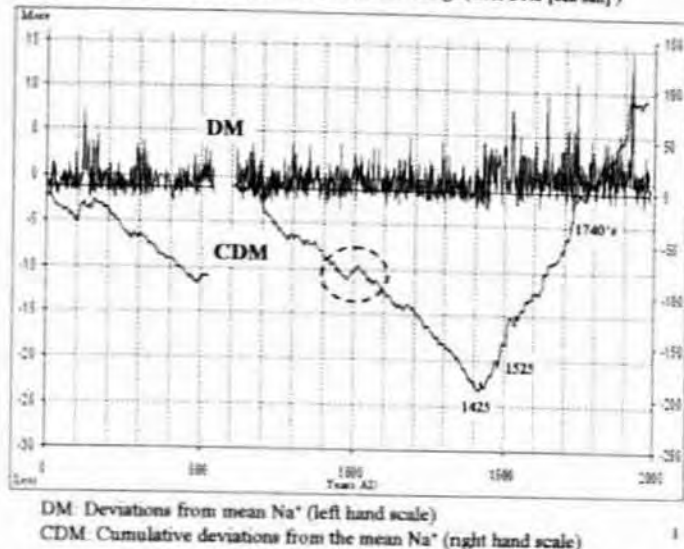


Fig. 7. Climate proxy data for the last 1,400 years. Two time series are shown deviation from the mean (DM) and cumulative deviations from the mean (CDM). Cumulative deviation is determined by calculating the long term mean for a data set, and the deviation of each point from the mean (DM). Then, beginning with the oldest data point, the deviations from the mean are summed in sequence; the cumulative deviation from the mean for year two is found by adding the year two deviation from the mean to year one deviation from the mean. The CDM for year three is found by adding the CDM for year two (year one DM plus year two DM) to the DM in year three. The CDM for year four is found by adding the CDM for year three (year one DM plus year two DM, plus year three DM) to the DM for year four, and so on. Fig. 7a. A proxy record for North Atlantic storminess change (GISP2 Na* [sea salt]) (Meeker and Mayewski 2002)

DM: Deviations from mean Na* (left hand scale)

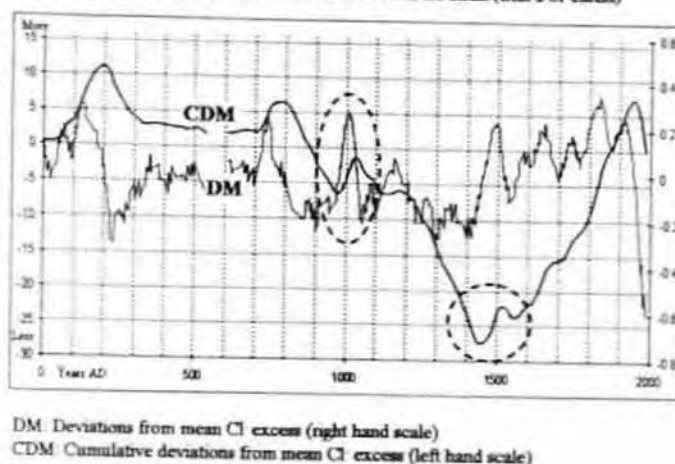
CDM: Cumulative deviations from the mean Na* (right hand scale)

Data from Greenland Ice Sheet Project 2.
<http://www.gisp2.sr.unh.edu/>

Europe were the result of ancient deforestation by people and the creation of 'cultural steppe' landscapes; in contrast the lack of trees in Iceland was a consequence of environmental constraints that prevented the development of woodland. As a result they would have had substantially different carrying capacities for livestock, and because the Icelandic plant communities were closer to their ecological limits they would have been more sensitive to change. Sustainable management options for Scandinavia, the British Isles and even the Faroe Islands would not necessarily be appropriate in Þórsmörk.

Additional sensitivity to soil erosion could have

Fig. 7b. A proxy record for Greenland Sea/ Davis Strait sea ice extent (GISP2 CI excess)



DM: Deviations from mean CI excess (right hand scale)

CDM: Cumulative deviations from mean CI excess (left hand scale)

Fig. 7b. A proxy record for Greenland Sea/ Davis Strait sea ice extent (GISP2 CI excess) (Mayewski et al. 1993)

DM: Deviations from mean CI excess (right hand scale)

CDM: Cumulative deviations from mean CI excess (left hand scale)

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been created in the rangeland areas of the Þórsmörk farms as a result of Katla tephra layers lying just below the vegetated surface at the time of settlement. These are shown as the layers below the Landnám tephra (V871) in IKAM2 and IKAM4 (Fig. 5). Crucially, the Þórsmörk farm sites lay closer to the volcanic fissures than the sites of farms to the west that were occupied for longer, and thus would have experienced thicker tephra falls in late pre-settlement times. Minor breaches of the vegetation cover could have exposed centimetre-scale unconsolidated tephra which would have eroded with ease. Additional stress could have been created for the similar fundamental reason of proximity to tephra sources, by eruptions in the time the farms were occupied. During the Katla eruption of 920 AD, fissures about 20 km to the east of Þórsmörk were active, and the main fallout was spread westwards, directly over the Þórsmörk farms. IKAM4 shows that in some areas the K920 tephra rapidly stabilised so that when the Eldgjá eruption followed some 15 years later, it formed a horizon that was distinctly separate (Fig. 5). In some areas however, instability is apparent after 920 AD that continued until the widespread return to fine-grained aeolian sedimentation in the 13th century (Fig. 5; IKAM 2).

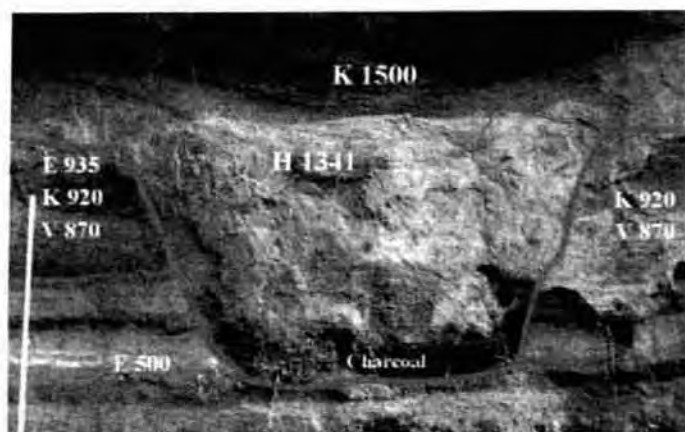


Fig. 8. Section of an eroding charcoal production pit (REU23) at Gigjökull.

This evidence for increased disturbance to the landscape coincides with climate changes as indicated by proxy records of storminess changes in the Greenland ice core records (GISP-2), that began in 975 AD and peaked in 1025 AD (Fig. 7a). In addition, proxy records of sea ice extent also from GISP-2, began to change in 980 AD and peaked in 1040 AD (Fig. 7b). The probable climate changes indicated in these proxy records cannot have produced major and ubiquitous landscape impacts on their own as there is little change in the sedimentary records from Stakkholt, but the small changes that are recorded there (Fig. 5; IKAM5 and IKAM11) could be contemporaneous. This would suggest that these 10th-11th century climate changes could have enhanced erosion already operating for different reasons. It is notable, however, that the erosion phases in Þórsmörk predate the major changes in atmospheric circulation in the North Atlantic that effectively mark the onset of the Little Ice Age between 1425-1450 AD (Fig. 7; Meeker and Mayewski 2002). Indeed, by this time regeneration had been established, as shown by the renewed accumulation of sediment, and continued without disruption.

The patterns of change we have discovered suggest that when the Þórsmörk farms were occupied soil erosion occurred and when they were abandoned limited stabilisation and expansion of soil cover resumed. This finding is important, but it begs the question whether it was these factors *exclusively* that triggered the abandonment of the farms. In this respect, the regional picture of woodland change is perhaps the key. Þórsmörk is notable because of the survival of woodland and its impor-

tance in the production of charcoal, a vital commodity for the carburizing of scythes, and as such essential for fodder production and the survival of a pastoral society. The general picture of woodland change in Iceland is one of rapid decline after the Norse settlement (Hallsdóttir 1987). In the area to the south of the Markarfljót river, woodland was cleared from the surroundings of the farm at Stóramörk by 920 AD (Mairs *et al.* this volume). Up stream from the farm, through Langanes (Fig. 1) and to within 5 km of the Þórsmörk settlements (but west of a series of glacial rivers, and, crucially, on the opposite side of Krossá) charcoal production is recorded in the form of seven charcoal production pits and three significant charcoal spreads that have been identified in eroding fluvial sections (Fig. 8, and see Table 1 for summary details). The final use of all the pits and spread of charcoal lenses occurred between the tephra falls of Eldjá 935 and Hekla 1341 and detailed age estimates of each site is possible through the relative position of the archaeology between these tephras. Analysis of the soil accumulation rate estimates indicates that the area was used for repeated episodes of charcoal production from the mid 10th century to the late 13th century. We have found no evidence of the practice continuing after the early 14th century. Our survey has considered rofbards and the eroding banks of most of the rivers and streams in Langanes; shallow exposures post-dating 1341 are most numerous but have revealed no evidence of charcoal production. The deeper, older exposures are less common but to date they have produced all the evidence of charcoal production. Although there is some historical evidence that the area was still being used for charcoal making in the 18th century (Tómasson 1996), we can speculate that a woodland/charcoal crisis developed by the 13th century as birch trees were progressively cleared up valley, and the frequency of charcoal production shifted in location and/or decreased. At that time, palaeoenvironmental evidence in the form of trace fossils within tephra layers, and the modern biogeography, indicates that extensive woodlands still survived in the enclosed valleys of Þórsmörk. Here the farms could have been experiencing environmental pressures driven by soil erosion and the loss of significant areas of grazing at about 350 m altitude. The final 'push' that drove desertion could therefore have been pressure from the lowland farms to conserve a shrinking, but

Table 1. Summary details of charcoal production pits in Langanes and around Gigjökull. Dating estimates based on aeolian sediment accumulation rates between the tephra layers E 935 and H 1341 and the associated archaeology.

Charcoal deposit site code	Description	Estimated date based on interpolation between tephra layers of known age
REU17	Pit with charcoal discovered during geomorphology survey and quarter-sectioned in 2003.	Mid to late 10 th century
REU23	Pit with charcoal; complete cross-section exposed in fluvial section in 2002.	Early to mid 11 th century
903CP1	Pit with charcoal; complete cross-section exposed in fluvial section in 2003.	Mid to late 10 th century
903CP2	Edge of pit with charcoal exposed in fluvial section in 2004.	Mid to late 12 th century
903CP3	Pit with charcoal; complete cross-section with two charcoal fills exposed in fluvial section in 2004.	Mid to late 10 th century
903CP4	Edge of pit with charcoal exposed in fluvial section in 2004.	Late 10 th to early 11 th century
903CP5	Pit with charcoal; complete cross-section exposed in fluvial section in 2003.	Mid to late 13 th century
903AS1	Ash and charcoal spread appearing in fluvial section in 2003.	Early to mid 11 th century
903AS2	Ash and charcoal spread appearing in fluvial section in 2003.	Early to mid 11 th century
903AS3	Ash and charcoal spread appearing in fluvial section in 2004.	Mid to late 13 th century

vital charcoal resource. Later woodland rights in Þórsmörk were held by, amongst others, the churches of Stóridalur, Oddi, Holt and Miðbæli. This suggests that the precise timing of abandonment was bound up in the politics of resources, and the power of the Church, but the situation had developed as a result of environmental changes (soil erosion and woodland loss) driven by human impacts.

CONCLUSIONS

We have found new evidence of landscape instability in Þórsmörk between the 10th and 13th centuries that resulted in localised episodes of soil erosion to bedrock that ended before 1300 AD. This activity is absent from the nearby (< 2km distant, but geomorphologically similar) district of Stakkholt, which is on the opposite side of a major river. Later, during the post 15th century 'Little Ice Age', landscape stability in Þórsmörk contrasts with episodes of instability in Stakkholt.

Þórsmörk was sensitive to early settlement impacts that led to extensive erosion. Extensive impacts may have occurred as a result of a series of factors including 'false analogies' being drawn by the first settlers because lands in late 9th century Iceland, superficially similar to contemporaneous landscapes in NW Europe, had in fact substantially different carrying capacities for livestock, leading to mistaken land management decisions. Sensitivity may have been increased by the presence of

tephra layers just under the surface that when exposed eroded rapidly. The geomorphic impacts of settlement may have been exacerbated by the 920 AD Katla tephra fall that could have buried short vegetation, clogged streams and enhanced erosion.

Environmental impacts in Þórsmörk may have also been exacerbated by 11th century climate changes, but the onset of the Little Ice Age in the 15th century is not related to degradation as recorded in the geomorphology.

After farm abandonment in Þórsmörk, the surviving woodlands were successfully conserved as a valuable source of charcoal for lowland farms where woodland resources had been diminished before 1341 AD. We suggest that a developing shortage of charcoal vital for successful farm operations could have precipitated the abandonment of the Þórsmörk settlements to permit the conservation of the surviving woodland for charcoal production.

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